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Quality profile of ginger under different management systems

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Abstract

Field experiments were conducted to find out the variation in yield, and quality profile of ginger under organic, inorganic and integrated management systems for three consecutive years (2007–2009). Ginger varieties, IISR Varada, IISR Mahima and IISR Rejatha were used for the experiment. Results showed that among the treatments, the yield was on par in organic and integrated management system. The oil content was significantly higher in integrated and inorganic management systems and oleoresin in inorganic system. The essential oil constituents *viz.*, zingiberene, farnesene, α-pinene, citral, 1, 8 cineole, z-citral and camphene contents were highest in integrated management system. β-Sesquiphellandrene content was highest under inorganic management and ar-curcumene content was highest under organic management system. Among the three varieties, IISR Mahima recorded significantly higher yield, oleoresin, β-Sesquiphellandrene and ar-curcumene contents. In the case of oil and zingiberene content, there was no significant difference among the varieties. IISR Varada recorded maximum oleoresin, α-pinene, citral, 1,8 cineole, z-citral and camphene content while IISR Rejatha recorded the highest farnesene and ar-curcumene content.

Keywords: ginger, management, yield, oil, oleoresin

Ginger (*Zingiber officinale* Rosc.) is one of the most important and widely used spices and it is valued for its aroma, flavor and medicinal properties. The aroma and flavor of ginger are determined by the composition of its steam volatile oil, which is comprised mainly of sesquiterpene hydrocarbons, monoterpene hydrocarbons and oxygenated monoterpenes (Zachariah *et al.* 2008). The monoterpene constituents are believed to be the most important contributors to the aroma of ginger and they tend to be relatively more abundant in the fresh rhizome than in the dried ginger. Oxygenated sesquiterpenes are relatively minor constituents of the volatile oil but appear to be significant contributors to its flavour properties. Soil type, agro climatic conditions, variety and management practices are some of the important factors, which could influence the yield and quality of the ginger (Zachariah *et al.* 1999). Srinivasan *et al.* (2000) reported maximum yield and oleoresin content in ginger due to application of FYM, coir pith compost and Azospirillum. The oil content was reported to be adversely affected by N application (Saraswath 1974). Organic ginger is high in demand and fetches premium price due to its high quality (Parthasarathy *et al.* 2008). Under the above circumstances, field experiments were conducted to study the variation in yield and quality of ginger under different management systems. The primary objective of this study was to understand the variations in quality profile of ginger grown under different management systems.

Field experiments were conducted to find out the variation in yield, nutrient availability, quality and oil composition under organic, inorganic and integrated management systems at IISR, Experimental Farm Peruvannamuzhi for three consecutive years, *viz.*, 2007 to 2009. The ginger varieties IISR Varanda, IISR Rejatha and IISR Mahima were planted 3 m × 1 m raised beds in split plot design. The following treatments were imposed while planting. T_1=100% Organic (30 t FYM + 2 t Neem cake + 1 t Ash + 4 t Vermicompost per ha, Biofertilizer - *Azospirillum* and *Pseudomonas* sp. as seed treatment and spray of BM and neem oil for disease and pest control); T_2=100% Inorganic (Recommended Dose of Fertilizer NPK @ 75, 50, 50 kg ha^{-1} and chemical means of pest and disease control); T_3=Integrated (20 t FYM + N/2, P, K of recommended dose of fertilizers + P-Solubilising Bacteria and spray with Dithane M 45 and Quinalphos for disease and pest control) respectively. The experiment was laid out in Split Plot design with ten replications. The crop was harvested at maturity and fresh yield data were recorded. Rhizome samples were taken treatment wise, peeled, dried, oil and oleoresin content were estimated as per standard procedures (ASTA 1982). Constituents of essential oil samples were analyzed using a gas chromatograph (Shimadzu GC 2010) equipped with mass spectrometer (Shimadzu QP-2010) and capillary column (RTX-5, 0.25µm × 0.32 mm × 30 mm). The column temperature was programmed as follows: injection port temperature-250°C; flow rate-1 mL min^{-1}; carrier gas-helium with a linear velocity of 48.1 cm sec^{-1}; split ratio-40; ionization energy-70eV and mass range 40-650 amu samples (0.1 mL^{-1}) were injected neat with 1:40 split ratio. The compounds were identified by comparison of their mass spectra with those recorded in Wiley and NIST libraries. Relative amounts of individual components are based on peaks obtained without FID response factor correction (Adams 1995). The three year data for three varieties and three treatments were subjected to statistical analysis as per standard methods.

Results showed that among the treatments, the yield was significantly high under organic management and integrated management system (Table 1). Cho *et al.* (1987) reported that organic nutrition helps to increase the yield and improve the quality of ginger. Application of organic cakes increased nutrient availability, improved the physical condition of the soil and increased the yield and oleoresin production. Khandkar & Nigam (1996) reported that yield increased with increase in the level of farm yard manure. Pawar & Patil (1991) opined that the yield was highest when fertilizers were applied in both organic and inorganic forms. Srinivasan *et al.* (2010) reported that application of FYM increased the soil quality and fresh rhizome yield in turmeric. The oil content was significantly highest in integrated and inorganic management system and oleoresin was highest in inorganic management system (Table 1). Gopalam & Ratnambal (1989) analyzed the essential oils obtained by hydrodistillation and steam distillation of seven popular cultivars of ginger using gas chromatograph and found great variation in the levels of the 13 identified compounds in the samples grown in 7 regions of India.

With regard to essential oil constituents (Table 2 & 3), zingiberene, farnesene, α-pinene, citral, 1,8 cineole, z-citral and camphene contents were highest under integrated management. β-sesquiphellandrene content was highest under inorganic management where as ar-curcumene content was highest under organic management system. Among the three varieties IISR Mahima recorded significantly higher yield, oleoresin, beta-sesquiphellandrene and ar-curcumene content. In the case of oil and zingiberene content, there was no difference among varieties. IISR Varada recorded maximum oleoresin, α-pinene, citral,

Table 1. *Yield, oil and oleoresin content of ginger under different management systems (Pooled mean of three years)*

Management practices	Yield (kg 3 m^{-2} beds)				Oil (%)				Oleoresin (%)			
	Varada	Mahima	Rejatha	Mean	Varada	Mahima	Rejatha	Mean	Varada	Mahima	Rejatha	Mean
Organic	8.01	7.54	7.39	7.64a	1.24	1.23	1.24	1.23b	3.79	3.82	3.41	3.67b
Integrated	7.35	8.58	6.89	7.61ab	1.49	1.43	1.36	1.42a	3.65	3.81	3.43	3.63b
Inorganic	6.43	8.18	6.44	7.02b	1.41	1.42	1.49	1.44a	3.94	4.19a	3.91	4.01a
Mean	7.26b	8.1a	6.90b		1.38	1.36	1.36		3.79 a	3.94 a	3.58 b	
CD (P<0.05)	M 0.62				M 1.10				M 0.21			
	V 0.62				V NS				V 0.21			
	V × M 1.1				V × M 0.18				V × M 0.36			

Table 2. Oil constituents of ginger under different management systems (Pooled mean of three years)

Management practices	Zingiberene (%)				Farnesene (%)				β-Sesquiphellandrene (%)				ar-curcumene (%)			
	Varada	Mahima	Rejatha	Mean	Varada	Mahima	Rejatha	Mean	Varada	Mahima	Rejatha	Mean	Varada	Mahima	Rejatha	Mean
Organic	12.40	14.69	15.23	14.11c	9.42	10.80	10.38	10.20b	8.75	10.78	8.71	9.42c	10.06	10.32	10.01	10.13a
Integrated	17.31	17.73	16.96	17.34a	11.35	11.66	12.67	11.89a	9.37	10.30	9.78	9.88b	7.72	8.52	8.09	8.12c
Inorganic	17.78	14.74	13.62	15.38b	12.12	10.77	11.88	11.59a	10.47	10.16	10.13	10.25a	8.73	9.57	10.13	9.48b
Mean	15.83	15.72	15.27		10.96b	11.08b	11.64a		9.53b	10.41a	9.53b		8.84b	9.49a	9.41a	
CD (P<0.05)	M 0.68				M 0.49				M 0.29				M 0.29			
	V NS				V 0.49				V 0.30				V 0.30			
	V × M 1.18				V × M 0.85				V × M 0.51				V × M 0.51			

Table 3. Oil constituents of ginger under different management systems (Pooled mean of three years)

Management practices	Camphene (%) Varada	Mahima	Rejatha	Mean	α pinene (%) Varada	Mahima	Rejatha	Mean	Citral (%) Varada	Mahima	Rejatha	Mean
Organic	5.57	5.06	5.11	5.25b	1.45	1.34	1.32	1.37 c	8.19	2.4	6.26	5.62 b
Integrated	7.02	6.13	6.09	6.42a	1.96	1.44	1.56	1.65 a	7.03	5.46	5.90	6.13 a
Inorganic	5.63	4.89	3.88	4.8c	1.88	1.36	1.20	1.48 b	5.39	4.7	5.16	5.07 c
Mean	6.08a	5.36b	5.03c		1.76 a	1.38 b	1.36 b		6.87 a	4.17 c	5.77 b	
CD (P<0.05)	V × M 0.48				V × M 0.22				V × M 0.60			
	M 0..28				M 0.11				M 0.30			
	V 0.28				V 0.11				V 0.30			

Management practices	Z-citral (%) Varada	Mahima	Rejatha	Mean	1,8 Cineole (%) Varada	Mahima	Rejatha	Mean
Organic	4.98	1.75	4.00	3.58 b	4.59	3.63	3.67	3.96 a
Integrated	4.42	3.57	3.75	3.91 a	5.02	3.7	3.49	4.07 a
Inorganic	3.42	2.95	3.27	3.22 c	3.37	3.13	3.4	3.30 b
Mean	4.27 a	2.76 c	3.68 b		4.32 a	3.49 b	3.53 b	
CD (P<0.05)	V × M 0.40				V × M 0.43			
	M 0.21				M 0.22			
	V 0.20				V 0.22			

1,8 cineole, z-citral and camphene content. IISR Rejatha recorded highest farnesene and ar-curcumene content. Among the varieties, IISR Mahima was found to be superior in terms of yield and quality. Zachariah (2008) reported that the oil yield is about 2–3% and the oil consists of 64% sesquiterpene hydrocarbons, 6% carbonyl compounds, 5% alcohols, 2% monoterpene drocarbons and 1% esters and the main compounds are zingiberene (29.5%) and sesquiphellandrene (18.4%). According to him the pungent compounds of ginger include gingerols, shogaols, paradols and zingerone, which produce a 'hot' sensation in the mouth and the composition of these constituents varies, based on maturity, genotype and agro climatic conditions. Erler *et al.* (1988) reported that the main components of Indian ginger oil were the sesquiterpenoid hydrocarbons, *ar*-curcumene, zingiberene, farnesene, bisabolene and sesquiphellandrene, while the essential oil from the Australian ginger consisted mainly of the monoterpenoid hydrocarbons, camphene and phellandrene, and their oxygen containing derivatives, neral, geranial and 1,8-cineol.

In brief, for ginger both organic and integrated management systems are on par with regard to yield. The oil content was significantly higher in integrated and inorganic management systems and oleoresin in inorganic system. The essential oil constituents *viz.*, zingiberene, farnesene, α-pinene, citral, 1, 8 cineole, z-citral and camphene contents were highest for integrated management system. β-Sesquiphellandrene content was highest under inorganic management and ar-curcumene content was highest under organic management system. Among the three varieties, IISR Mahima recorded significantly higher yield, oleoresin, β-Sesquiphellandrene and ar-curcumene contents. In the case of oil and zingiberene content, there was no significant difference among the varieties.

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